LA-UR-77-1563

VOLUME 24
TANSAO 24 1-510 (1976)

1976 WINTER MEETING

WASHINGTON, D.C.

NOVEMBER 14-19, 1976

INTERNATIONAL CONFERENCE

ON

WORLD NUCLEAR ENERGY—A STATUS REPORT

AMERICAN NUCLEAR SOCIETY

TRANSACTIONS

C. J. KERSHNER and J. C. BIXEL, "Tritium Effluent Control Project Progress Report, January-March 1975," pp. 14-26 (Aug. 1975).

10. L. L. BERGER, Personal Communication, Battelle Pacific Northwest Laboratories (June 1976).

6. Iodine-131 Air Concentrations: A Comparison of Calculated Versus Measured Values, *T. W. Oakes, K. E. Shank, C. E. Easterly (ORNL)*

The Oak Ridge National Laboratory (ORNL) maintains five stacks that discharge radioactive material into the atmosphere from different locations within the Laboratory. Practically all the ^{131}I is released from two 76.2-m stacks. Airborne radioiodine concentrations are measured by two separate monitoring networks: (a) the local radioiodine monitoring (LRM) network, which consists of eight stations located relatively close to the ORNL operational activities; and (b) the perimeter radioiodine monitoring (PRM) network, which consists of nine stations around the perimeter of the area controlled by the U.S. Energy Research and Development Administration—Oak Ridge Operations. All the monitors sample air at a regulated flow rate through a Hollingsworth and Voss HV-70 particulate filter. A charcoal cartridge filter on the downstream side of the particulate filter is used for the collection of iodine. Each station is serviced on a weekly basis, and the filters are analyzed by gamma spectrometry.

A computer program[1] was used to calculate ground-level air concentrations of ^{131}I. The diffusion equations used for these calculations are based on the Gaussian plume model developed by Pasquill[2] and modified by Gifford.[3] This program is based on a continuous release and corrects for plume depletion via radioactive decay and deposition. The meteorological data used in the dispersion calculations consist of over 62,000 individual measurements made at ORNL during the period 1960-68.[4] These data were separated into two Pasquill stability classes, C and E, and were reduced to 8 discrete wind speeds and the 16 cardinal directions. For the calculations, the maximum vertical dispersion coefficient was assumed to be 37.6 m, and the deposition rate was taken to be 10^{-4} m/s.

Calculated annual average ground-level concentrations of ^{131}I at the location of each of the 17 sampling stations for the period of 1965-75 have been compared to measured values. These comparisons for the period of

TABLE I

Comparisions of the Data Collected by the Local and Perimeter Radioiodine Monitoring Networks with Calculated Values

Station Identification Number	Distance From Main Stack (m)	$\left(\frac{\text{Measured Value-Calculated Value}}{\text{Measured Value}}\right) \times 100$ (%)					
		1965	1966	1967	1968	1969	|Average|
		Perimeter Network					
HP-31 KERR H.	11,270	-102	-38	-38	- 6	+13	39
HP-32 MIDW.G.	10,860	- 25	-24	-25	-10	+16	20
HP-33 GAL.GATE	6,840	- 14	+10	+19	+25	+42	22
HP-34 WOD	3,220	- 43	-75	-22	+22	-50	42
HP-35 BLAIR G.	7,640	- 7	+11	+ 3	+46	+39	21
HP-36 TPK G.	6,040	- 13	-24	-78	+ 8	-30	31
HP-37 HICK. CR	7,850	+ 8	+21	- 1	+53	+29	22
HP-38 EGCR	5,630	- 12	+18	+ 0.8	+33	+24	18
HP-39 TOWN	12,870	-	-	+ 0.6	+41	-10	17
|Average|		28	28	21	27	28	26
		Local Network[a]					
HP-7	500	NIS[b]	+45	+57	+31	+71	51
HP-8	7,650	NIS[b]	- 0.6	+ 6	+29	+58	23
HP-9	380	NIS[b]	+95	+97	+94	+97	96
HP-16	530	NIS[b]	+70	+83	+75	+83	78
|Average|		NIS[b]	53	61	58	77	62

[a] Only those stations not in close proximity to laboratory buildings are listed.
[b] Not in service.

1965-69 are shown in Table I. After 1970, most of the measured values were below the minimum detectable limit and direct comparisons are meaningless. The comparisons are shown as the percentage deviation of the calculated values from the measured values. With only three exceptions, the measured and calculated values for the PRM system agree to within 50%, and the values of the 43 comparisons are equally distributed about zero. The comparisons for the LRM system do not show such consistent agreement, but this was expected as many of these stations are in close proximity to the stacks and laboratory buildings.

In conclusion, the comparisons for the PRM stations demonstrate that the Gaussian plume model is appropriate for routine annual releases, in that, for distances between 3,000 and 13,000 m, agreement between the measured and calculated values of ^{131}I air concentrations is consistently within a factor of 2. In addition, it is noted from the selected LRM system data presented, that as the distance between the air monitoring stations and the stacks increases from 380 to 7,650 m, the calculated values approach the measured values.

1. M. REEVES, P. G. FOWLER, and K. E. COWSER, "A Computer Code for Routine Atmospheric Releases of Short-Lived Radioactive Nuclides," ORNL-TM-3613 (1972).
2. F. PASQUILL, *Atmospheric Diffusion*, D. Van Nostrand Co., Ltd., London (1962).
3. F. A. GIFFORD, Jr., *The Problem of Forecasting Dispersion in the Lower Atmosphere*, (booklet) USAEC, DTI (1962).
4. F. T. BINFORD, T. P. HAMRICK, and B. H. COPE, "Some Techniques for Estimating the Results of the Emission of Radioactive Effluent from ORNL Stacks," ORNL-TM-3187 (1970).

7. Dispersion of Bromine from Auto Exhaust—A Simple Diffusion Model, *D. J. Adair,* T. F. Parkinson (VPI & SU)*

Extensive measurements of the distribution of bromine from auto exhaust have been carried out using the method of neutron activation analysis.[1] Over 1200 samples of soil and grass were collected downwind from two major highways. Other studies[2] have shown that Br and Cl from automobiles disperse as an aerosol and are associated with Pb Cl Br particulates. For the Br concentrations in soil samples from one highway, several anomalous maxima in Br concentrations were obtained. These maxima correlated very closely with slight elevations and depressions in the terrain. The purpose of this work was to develop a model for the aerosol dispersion. Extensive work to calculate doses from the dispersion of radionuclides has been reported. For example, the program GRONK[3] is similar in many respects to our model and is used to calculate radiation exposures from a point source emitting radionuclides.

For a point source of emission in a nonisotropic atmosphere, the concentration, χ, is given by Sutton's equation[4,5]

$$\chi(x,y,z,t) = \frac{Q}{(4\pi t)^{3/2}(\kappa_x\kappa_y\kappa_z)^{1/2}} \exp\left[-\frac{1}{4t}\left(\frac{x^2}{\kappa_x}+\frac{y^2}{\kappa_y}+\frac{z^2}{\kappa_z}\right)\right] , \quad (1)$$

where Q is the source term and κ_x, κ_y, and κ_z are dispersion coefficients in the x, y, and z directions, respectively. To account for dispersion due to a constant wind of velocity v_x in the x-direction, Eq. (2) was developed

$$\chi(x,y,z,t) = \frac{Q'}{4\pi v_x t(\kappa_y\kappa_z)^{1/2}} \exp\left[-\frac{1}{4t}\left(\frac{y^2}{\kappa_y}+\frac{z^2}{\kappa_z}\right)\right] , \quad (2)$$

where $Q = Q'dt$.

Thus, the distribution is Gaussian in the y and z directions with standard deviations, σ_y and σ_z, given by

$$\sigma_y^2 = 2t\kappa_y, \sigma_z^2 = 2t\kappa_z , \quad (3),(4)$$

and Eq. (2) can be written

$$\chi(x,y,z,v_x) = \frac{Q'}{2\pi v_x\sigma_y\sigma_z} \exp\left[-\left(\frac{y^2}{2\sigma_y^2}+\frac{z^2}{2\sigma_z^2}\right)\right] . \quad (5)$$

Using the method of images, we can account for emission from a point source at altitude, h

$$\chi(x,y,h,v_x) = \frac{Q'}{\pi v_x\sigma_y\sigma_z} \exp\left[-\left(\frac{y^2}{2\sigma_y^2}+\frac{h^2}{2\sigma_z^2}\right)\right] . \quad (6)$$

To convert from a point source to a line source, we integrate Eq. (6) over the y axis and obtain

$$\chi(x,h,v_x) = \frac{Q'}{\sqrt{2\pi}\, v_x\sigma_z} \exp\left(-\frac{h^2}{2\sigma_z^2}\right) . \quad (7)$$

Since the wind velocity is a function of height, z, we incorporate the following relation into the model:

$$v(z) = v_1\left(\frac{z}{z_1}\right)^m , \quad 0 \le m \le 1 , \quad (8)$$

where v_1 is the mean velocity at height z_1. Substituting into Eq. (7) yields

$$\chi(x,z,v) = \frac{Q'z_1^m}{\sqrt{2\pi}\,\sigma_z v_1 z^m} \exp\left[-\frac{(h-z)^2}{2\sigma_z^2}\right] . \quad (9)$$

A final modification is made to the model to account for the dependence of v_1 as a function of distance x; this dependence is assumed to be sinusoidal, so that

$$\chi(x,z,v) = \frac{Q'z_1^m \sin[f(x)]}{\sqrt{2\pi}\,\sigma_z v_1 z^m} \exp\left[-\frac{(h-z)^2}{2\sigma_z^2}\right] . \quad (10)$$

A comparison of the measured distribution of Br and the calculated Br concentration from Eq. (10) is shown in Fig. 1. The simple diffusion model is capable of reproducing the major features of the Br dispersion.

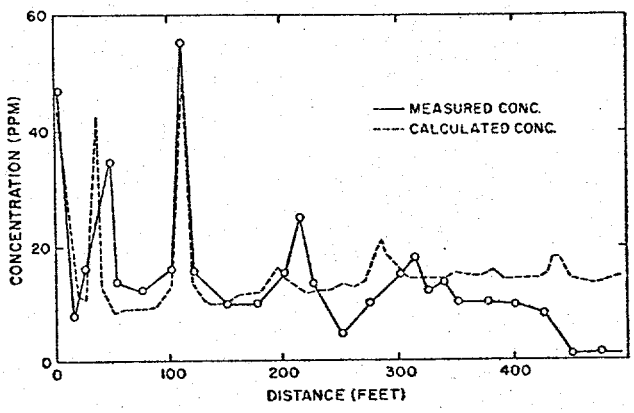

Fig. 1. Measured and calculated distributions of Br in soil.

*Present address: Westinghouse-Hanford Co., Richland, Washington.